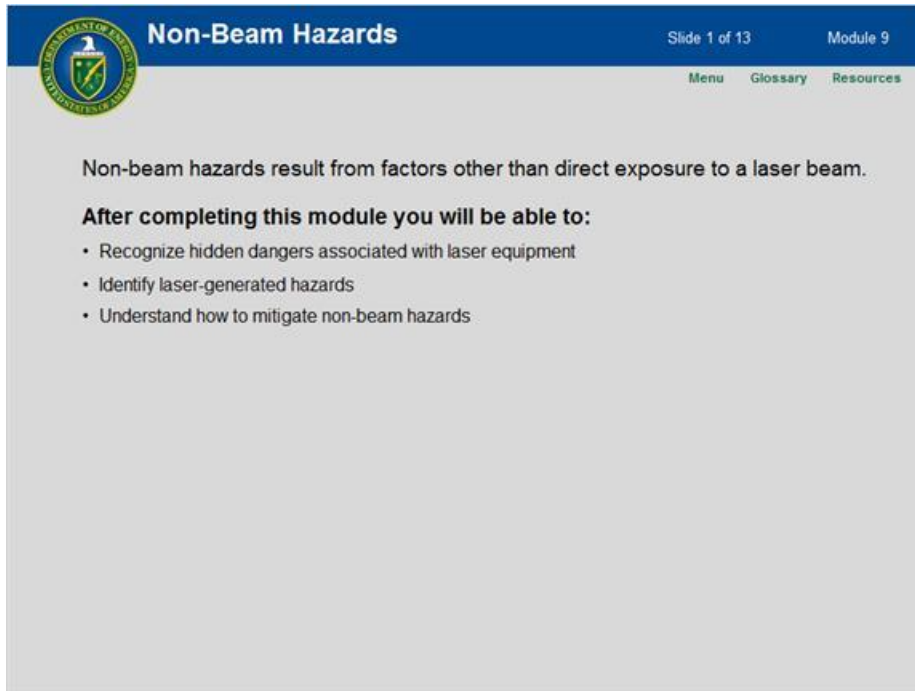


Slide 1 Non-Beam Hazards



The screenshot shows a presentation slide with a blue header bar. On the left is a circular logo for the University of Maryland System. The header text reads 'Non-Beam Hazards'. To the right of the header, it says 'Slide 1 of 13' and 'Module 9'. Below the header, there are three links: 'Menu', 'Glossary', and 'Resources'. The main content area is light gray and contains the following text:

Non-beam hazards result from factors other than direct exposure to a laser beam.

After completing this module you will be able to:

- Recognize hidden dangers associated with laser equipment
- Identify laser-generated hazards
- Understand how to mitigate non-beam hazards

All too often, laser users fall into the trap of becoming so concerned with laser protective eyewear that they forget about other hazards around them. Next to eye injury, the most common laser accident is electrical shock. So far, all deaths associated with lasers have been from electrocution or fire. This module discusses non-beam hazards. These are hazards that result from factors other than direct exposure to a laser beam. After completing this module, you will be able to recognize hidden dangers associated with laser equipment, identify laser-generated hazards, and understand how to mitigate non-beam hazards.

Slide 2 Non-Beam Hazards

Laser Worker Training

Non-Beam Hazards

Slide 2 of 13 Module: 9



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Equipment-related hazards:


- Electrical
- Fire or explosion
- Non-laser radiation
- Chemical (gases, dyes)
- Pressure
- Noise
- Housekeeping


Laser-generated hazards:

- Air contaminants (including fumes, nanoparticles)
- Plasma radiation



DANGER	
	HIGH VOLTAGE


DANGER	
	Flammable Gas

WARNING	
	Toxic and corrosive gases

There is much more to laser safety than preventing eye and skin injuries. Laser equipment can introduce other hazards in addition to the laser beam. Equipment-related hazards include: electrical, fire or explosions; non-laser radiation, such as RF or X-rays; chemical, pressure, noise, and poor housekeeping that creates trip hazards or results in too much clutter on optics tables. There can also be laser-generated hazards, which include air contaminants, and plasma radiation. Let's look at some of these in more detail.

Slide 3 Non-Beam Hazards

Laser Worker Training



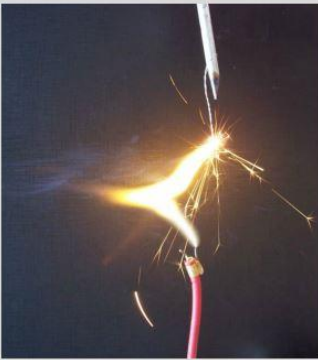
Non-Beam Hazards

Slide 3 of 13 Module: 9

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Electrical Hazards

- Shock
- Resistive heating
- Spark ignition of flammables



Loss of life from electric shock has occurred during servicing and testing of laser equipment, making electrical safety a top concern. Electrical hazards include: shock, resistive heating, spark ignition of flammables, and stored energy — such as in capacitors.

Slide 4 Non-Beam Hazards

Laser Worker Training

Non-Beam Hazards

Slide 4 of 13 Module: 9


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Electrical Hazard Controls

- Electrical Safety Training
- Lockout Tagout (LOTO) and zero energy verification
- Grounding - equipment and tables
- Equipment certification: NRTL (e.g., UL) or from qualified electrical safety personnel

Contact your Electrical Safety Officer

Recognized NRTL Labels




The image shows a grid of 24 circular and rectangular logos for various Nationally Recognized Testing Laboratories (NRTLs). These logos are arranged in four rows and six columns. Some of the recognizable logos include UL, ETL, and others with different symbols and text. Below the grid, there is a small line of text that reads 'Recognized NRTL Labels'.

Anyone working with Class 3B or Class 4 lasers may require additional electrical safety training. This can include Lockout Tagout, which is sometimes referred to as LOTO. Always perform a zero energy check before working on equipment, which should be part of the LOTO procedure. Be aware of stored energy sources and take proper precautions. A laser user must be aware of basic electrical safety concepts, such as proper grounding of lasers and optic tables, and discharging of capacitors. Wires, plugs, and connectors should be frequently evaluated for signs of damage or wear. Electrical equipment always needs to pass a certification test, either from a Nationally Recognized Testing Laboratory such as UL, or from qualified electrical safety personnel at your facility. For assistance addressing any electrical safety concerns, contact your Electrical Safety Officer.

Slide 5 Non-Beam Hazards

Laser Worker Training



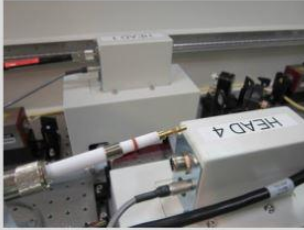

Non-Beam Hazards

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Electrical Hazard Problem Areas

- HV connectors that are not touchsafe
- Exposed electrical terminals
- Failure to discharge and ground capacitors
- Improperly grounded equipment
- Unsafe cable routing
- Inadequate safety training (including CPR)
- Failure to comply with OSHA LOTO requirements



Potential electrical problem areas include: high voltage connectors that are not touchsafe, exposed or improperly insulated electrical terminals, failure to properly discharge and ground capacitors, non earth-grounded or improperly grounded equipment, unsafe cable routing; inadequate electrical safety training, including CPR, and failure to comply with OSHA Lockout/Tagout requirements. Let's look at a few of these areas in more detail.

Slide 6 Non-Beam Hazards



Non-Beam Hazards

Slide 6 of 13 Module 9


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Exposed Terminals

Don't assume the manufacturer has adequately addressed electrical safety!



Exposed terminals




Protective cover installed

Often maintenance, alignment, or servicing requires removal of covers to access internal components. Normally protected electrical terminals might become accessible, exposing workers to a shock or possibly electrocution hazard. Don't assume the manufacturer has adequately addressed electrical safety! Exposed terminal hazards can be mitigated by installing simple covers.

Slide 7 Non-Beam Hazards

Laser Worker Training test

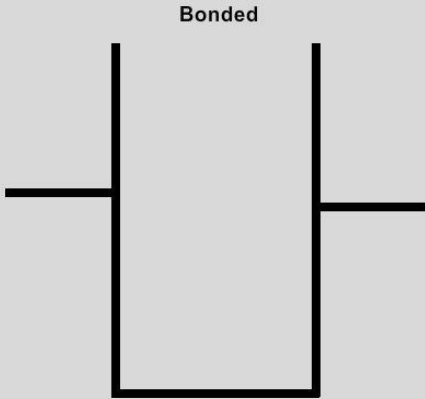



Non-Beam Hazards

Slide 7 of 13 Module: 9

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Grounding or Bonding of Capacitors



Contact your Electrical Safety Officer!

Capacitors can store hazardous energy. They can be discharged with a grounding hook and some may need to be bonded during service. Consult your electrical safety officer for assistance.

Slide 8 Non-Beam Hazards




Non-Beam Hazards


Slide 8 of 13 Module 9

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Cable Routing



Don't do this!



Improper cable routing causes trip hazards, cable damage and other hazards. Properly routed cables, gas, and water lines create a safe work environment.

Slide 9 Non-Beam Hazards



Non-Beam Hazards

Slide 9 of 13 Module 9

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Fire and Explosion Hazards

- Electrical spark
- Lamps
- Capacitor banks
- Class 4 lasers



Laser equipment presents potential fire and explosion hazards. Laser electrical systems can cause resistive heating or spark ignition of flammable materials. High pressure arc lamps, filament lamps and capacitor banks in laser equipment pose potential explosion hazards. Shattering of the laser target and optical components are a potential hazard with higher power lasers. Class 4 laser beams can ignite material from laser-target interactions.

Slide 10 Non-Beam Hazards




Non-Beam Hazards

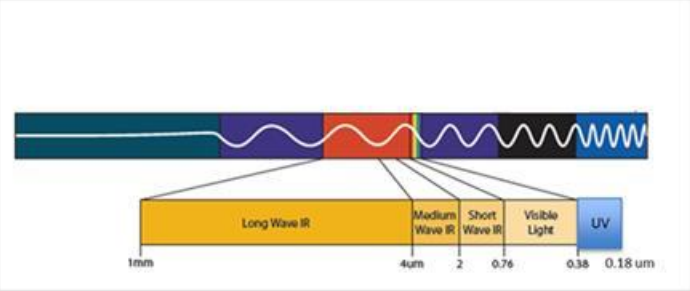
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Non-laser Radiation from Laser Equipment

- Static magnetic fields - Faraday rotators
- RF - power supplies
- Optical radiation - discharge tubes and flashlamps
- X-Rays - HV components above 15 kV






Laser equipment can generate radiation hazards that are unrelated to the laser beam. Faraday rotators can have significant static magnetic fields. The electromagnetic spectrum spans wavelengths both longer and shorter than visible wavelengths. Radio frequency, or RF energy can be created by power supplies and other laser electrical equipment. Optical radiation can come from laser discharge tubes and flashlamps, and X-ray radiation may be emitted by laser high voltage components above 15 kiloVolts.

Slide 11 Non-Beam Hazards

Laser Worker Training test



Non-Beam Hazards

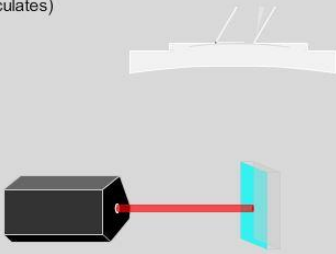
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Fumes and Laser-Generated Air Contaminants

Beware of:


- Smoke and odors
- Unsuspected byproducts (gases, particulates)



Contact your Industrial Hygienist

If you see or smell smoke or an odor, some type of local ventilation may be needed. For example, laser interactions with a target can generate unsuspected byproducts. These byproducts could include volatile gases and particulates, and may contain carcinogens. Inhaling gases and particulates can damage your lungs. Contact your Industrial Hygienist if fumes or air contaminants are a concern.

Slide 12 Non-Beam Hazards

**Non-Beam Hazards**


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High Intensity Laser-target Interactions

- Air contaminants: $> 10^3 \text{ W/cm}^2$
- Plasma Radiation: $> 10^{12} \text{ W/cm}^2$
- Ionizing Radiation: $> 10^{16} \text{ W/cm}^2$

Contact a Health Physicist.



Laser-target interactions can generate air contaminants at intensities as low as one thousand watts per centimeter squared. At higher intensities, these interactions can generate plasma radiation and even ionizing radiation. Non-ionizing plasma radiation can include hazardous levels of UV and blue light. Ionizing radiation may also be emitted by plasmas when the laser irradiance on a target exceeds 10^{16} watts per centimeter squared. Contact your Health Physicist if generating ionizing radiation is a concern.

Slide 13 Non-Beam Hazards

**Non-Beam Hazards**

Slide 13 of 13 Module 9

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Human Factors and Ergonomics



People's actions and a lab's configuration can add hazards as well. Typical problem areas include: limited work spaces, which can lead to laser beams at different heights or awkward working positions; poor housekeeping, which can lead to trip hazards, fires or even electrocution; repetitive motion tasks, inadequate lighting levels; and work patterns – off-normal or excessive work hours affect alertness and can lead to mistakes. Familiarity or complacency can lead workers to forget hazards and put themselves at risk. Be alert to unexpected sounds, smells or other changes in the lab. Respect laser systems and the risks they pose!